DEC STD 067-0 ELECTROSTATIC DISCHARGE-SENSITIVE DEVICES

DOCUMENT IDENTIFIER: A-DS-EL00067-00-0 Rev E, 27-Dec-1989

ABSTRACT: This document, in conjunction with the five other sections of DEC STD 067, provide Corporate-wide requirements for electrostatic discharge (ESD) control. This document is to connect all sections of DEC STD 067, provide general information and sources, and provide methods for device classification.

APPLICABILITY: This section is mandatory for all areas in Digital that deal directly or indirectly with the handling of devices sensitive to electrostatic discharge, as covered by Sections -01 through -05 of this standard.

STATUS: APPROVED 27-Dec-1989; use VTX SMC for current status.

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Responsible Person:	Jack Kane
Author:	Adrienne Kudlich

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Jack Kane, Standard Owner

Eric Williams, Standards Process Manager

Direct requests for further information to:

Adrienne Kudlich

NRO5/F2, DTN: 234-4532, FRAGLE::KUDLICH

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide internationally applicable information on the handling of electrostatic discharge (ESD) sensitive material. This section of DEC STD 067 provides general information applicable to all other sections of the standard, including device classification levels and test methods, a glossary of ESD terms, and a list of reference materials. This section also provides an overview of the other sections of DEC STD 067.

1.2 SCOPE

This document applies to all areas where electrostatic discharge (ESD) sensitive materials are handled. This applies to all processes, including engineering, manufacturing, and field operations processes. Information included herein applies to material procurement, therefore, this document also applies to purchasing areas.

1.3 RESPONSIBILITIES

It is the responsibility of EOS/ESD Control Engineering to maintain this document and aid in the implementation of its requirements. The person responsible for the technical content of this section of the standard is Adrienne Kudlich at FRAGLE::KUDLICH.

2 DOCUMENT DESCRIPTION

This standard has been designed for the end user. It consists of five sections for three areas where ESD control is required. They are, engineering, manufacturing, and field operations, and two companion areas, packaging and materials. This approach allows a manager setting up a manufacturing floor to primarily follow *DEC STD 067-3 Electrostatic Discharge-Sensitive Devices: In Manufacturing Facilities*, with guidance from this section for additional information. The specifications of any section of this standard may be imposed on suppliers of products or materials to Digital, in the product's specification, shipping style, production style, or any other way needed.

2.1 ENGINEERING SECTION, *DEC STD 067-1 ELECTROSTATIC DISCHARGE-SENSITIVE DEVICES: IN ENGINEERING FACILITIES*

The treatment in the Engineering section is the most scientific. Included in this section are a full description of the static electricity phenomena; general protection procedures for work areas, storage areas, personnel and transportation; and personnel safety information.

Product development and protection is also included in this section. For this reason, section 1 is company classified, unlike the other sections of the standard. This section is designed to be used from the initial product inception to final design phases. It also discusses ESD sensitivity testing and available standards and their applicability.

2.2 PACKAGING SECTION, *DEC STD 067-2 ELECTROSTATIC DISCHARGE-SENSITIVE DEVICES: PROCEDURES AND PROTECTIVE PACKAGING MATERIALS*

Protective packaging allows marginally protected or unprotected products to move around without being damaged. DEC STD 067-2 deals with all types of ESD protective packaging. Packaging is dealt with by two areas within Digital, Industrial Packaging Engineering (IPE) at MLO, and Customer Service Logistics Product Protection (CSLPP) at DAS.

Packaging has many classifications, according to resistivity or shielding capabilities and construction. This document discusses conductive, static-dissipative materials, antistatic materials (do not cause static electricity to build up), and shielding materials. Shielding or Faraday cage materials include buried metalized layer material, conductive plastic, and metal containers.

The recommendations for use of each of these types of materials are discussed in this document. Construction parameters for various types of material are also discussed, including foams, thin and thick films, and solid plastics. Warnings are included, where necessary, to indicate types of materials that change during processing or by aging.

Testing procedures are not described in this document. Packaging materials are qualified under Digital 99 Class specifications. Material specifications and test procedures are addressed where applicable. Testing requirements (such as for incoming inspection) are described as required.

2.3 MANUFACTURING SECTION, *DEC STD 067-3 ELECTROSTATIC DISCHARGE-SENSITIVE DEVICES: IN MANUFACTURING FACILITIES*

DEC STD 067-3 deals with the setup of all manufacturing areas for full ESD protection. It describes the various work areas and general protection procedures for these areas; training courses and necessary certifications; shipping, receiving, stores and distribution; safety precautions; and auditing procedures for manufacturing. It is the most general section of DEC STD 067, covering all areas from procurement (post-design phases) to final shipment.

2.4 FIELD OPERATIONS SECTION, *DEC STD 067-4 ELECTROSTATIC DISCHARGE-SENSITIVE DEVICES: IN CUSTOMER SERVICE AREAS*

DEC STD 067-4 provides detailed guidelines and requirements for all Customer Service areas, including Customer Service Operations, Engineering, Manufacturing, Logistics, Stocking Facilities, and Customer Service Support. It proceeds from DEC STD 067-3, covering areas from product shipment through the final stages of product life. It establishes rules for repair and rework, stores, distribution and support operations. It also describes protection procedures for work and storage areas, as well as customer site installations and branch operations. Training requirements and the certification process are discussed. General equipment requirements for monitoring and operation of an ESD-controlled area are described.

2.5 MATERIALS SECTION, *DEC STD 067-5 ELECTROSTATIC DISCHARGE-SENSITIVE DEVICES: RELATED MATERIALS AND PRODUCTS*

DEC STD 067-5 provides detailed descriptions for flooring, instrumentation, personnel equipment, work area equipment, monitors and testers, and more. Each description provides information on the product applicability, calibration, range, inherent characteristics, and history and development (where applicable). This section should be used by Purchasing and Engineering to ensure adequate ESD protection when a qualified product list (QPL) does not exist. QPLs and recommended product lists (RPLs) are not included in this document, but are referenced as applicable. This section should also be used by areas procuring, selecting, and calibrating ESD protective materials.

3 STATIC ELECTRICITY CONTROL

Static electricity is a complex phenomena, affecting various devices and materials in many different ways. These effects are discussed in each respective section of this standard. The Engineering section, DEC STD 067-1, gives a full description of the phenomena. The Manufacturing and Customer Operations sections, DEC STD 067-3 and 067-4, discuss the ramifications of static electricity and electrostatic discharge (ESD) as it applies to these areas. The Materials and Packaging documents, DEC STD 067-5 and 067-2, discuss ESD protection and material properties.

Refer to the applicable section for a full discussion of ESD topics.

3.1 INFORMATION SOURCES

ESD information is available in many places, including the list of referenced documents in Appendix A.

Internally, EOS/ESD Control Engineering in Northboro, MA (NRO5/F2) coordinates many of Digital's ESD issues. Tasks currently handled by this group are as follows.

- Design verification for ESD sensitivity
- Failure analysis of components and systems
- Development of hardware solutions and test methodology
- Qualification of ESD protective materials and personnel gear
- Qualification of ESD protective work environment equipment

This group has developed a modular training course tailored to individual needs. Contact FRAGLE::EOS_ESD, or DTN 234-4532.

The EOS/ESD Association based in Rome, NY, holds annual symposia and publishes proceedings. They are active in writing industry standards. The address for this group is:

EOS/ESD Association Inc., Norstar Bldg., 200 Liberty Plaza, Rome, NY 13440

The Northeast EOS/ESD Group is a local chapter of the EOS/ESD Association. It meets regularly, at bimonthly meetings. The address for this group is:

Northeast EOS/ESD Group, P. O. Box 256, Berlin, MA 01503

Additional sources of specific information can be acquired by contacting any of these groups.

4 DEVICE CLASSIFICATION

The word *device* implies all discrete components including passive components, ICs, chip sets, assemblies (daughter and mother boards), customer installable units and field replaceable units that are produced or purchased by Digital to be included in Digital products. To ensure full protection (without loss of revenue due to overprotection) these devices must be tested and classified to make effective protection possible.

4.1 CLASSIFICATION LEVELS

The device classification levels are adapted from EOS/ESD-S5, *Human Body Model (HBM) Electrostatic Discharge Sensitivity Testing Draft Standard*, dated April, 1988. The classification levels agree with military classification levels, with the addition of subclasses for more defined classification.

4.2 TEST METHOD FOR DETERMINING ESD SENSITIVITY

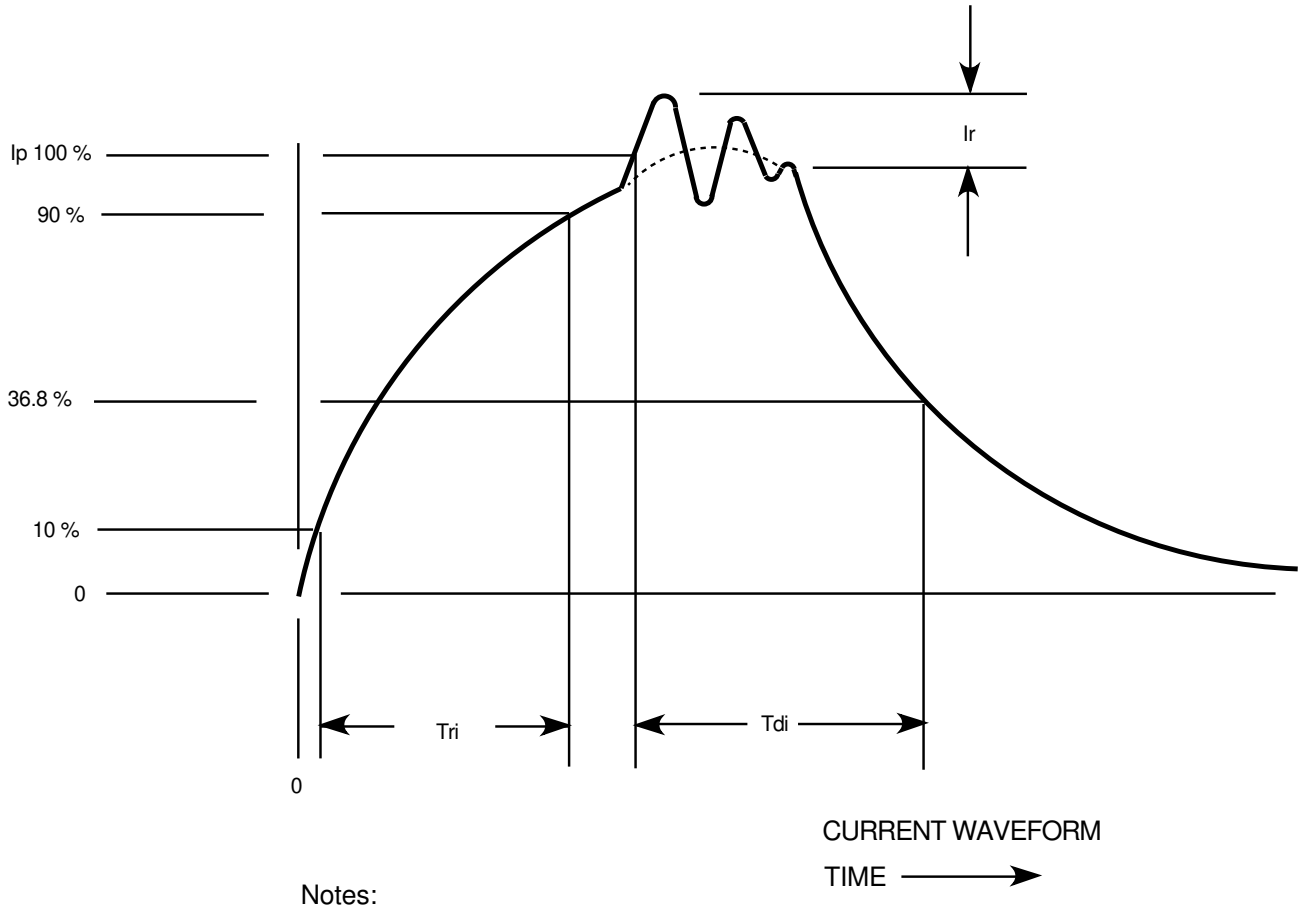
The following test method for determining ESD sensitivity is taken from EOS/ESD-S5, (HBM of 1500 ohms, 100 pF for IC Testing). Please refer to this document or to MIL STD 883C for the complete test method and clarification. The EOS/ESD Association standard is basically the same test method as the military standard, with the exception that EOS /ESD-S5 includes a more accurate method of waveform verification. Key points from these standards are listed below.

4.2.1 Apparatus

An ESD simulator and device under test (DUT) socket equivalent to the circuit described in EOS/ESD-S5 must be used for the ESD sensitivity test. This must include a discharge network representing a human body model (HBM) of 1500 ohms and 100 pF. The simulator shall be capable of supplying pulses with the characteristics described in Figures 1 and 2.

All measurement equipment shall have a minimum band width of 350 MHz.

Figure 1: Human Body Model (HBM) Characteristic Waveform



Notes:

1. The current waveform shown is fully described in MIL–STD–883C, Method 3015.6.

2. The current pulse shall have the following characteristics:

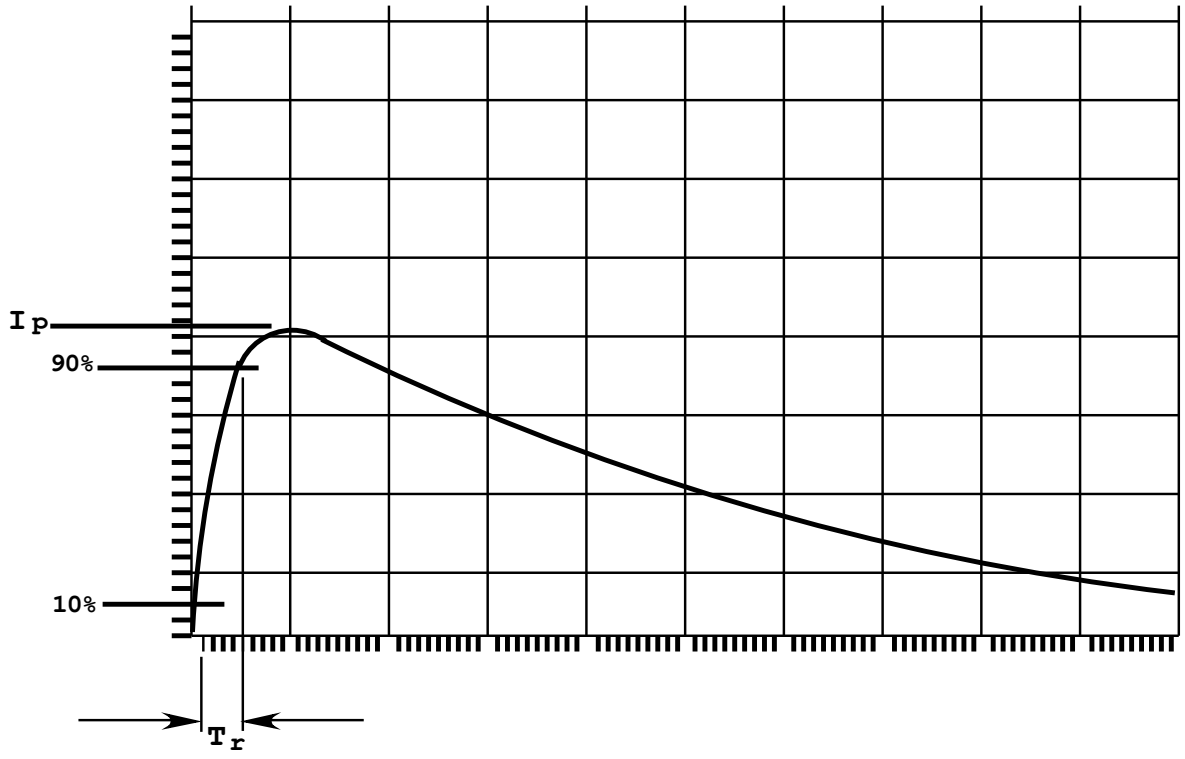
   Tri: (Rise Time) less than 10 nanoseconds.

   Tdi: (Decay Time) 150 ±20 nanoseconds.

   Ip: (Peak Current) see MIL–STD–883C, Method 3015.6 for details.

   Ir: (Ringing) see MIL–STD–883C, Method 3015.6 for details.

Figure 2: Current Waveform Through a 500-Ohm Resistor



1. The current pulse shall meet the following characteristics:

   T_r Pulse rise time 5 nanoseconds to 20 nanoseconds.

   I_r The maximum allowable peak to peak ringing must be less then 15% of I_p, with no observable ringing 100 nanoseconds after the start of the pulse.

   I_p Peak current shall be within 10% of the value specified in Table 1, ESD Step Stress Levels, for I_{pr}. Also, it should not be less than 63% of the previously measured I_{ps} value for the same stress level.

2. It is not necessary to measure T_d, pulse decay time of the current through the 500 ohm resistor, as this will vary, depending upon how the ESD simulator forms the pulse.

4.2.2 Classification Test Method

4.2.2.1 Waveform Verification

The waveform shall be verified during each shift where testing is performed according to EOS/ESD-S5. This calls for discharge of the ESD pulse through a short circuit and through a 500-ohm resistor. The current is measured using a high bandwidth current probe (such as the Tektronix CT-1) and compared to Table 1.

The following is from EOS/ESD-S5, section 7.6, Table II.

Table 1: ESD Step Stress Levels

Step	Ips	Ipr		Vpr
	Peak current into a short	Peak current into 500 ohms		Equivalent peak voltage
		0 pF[1]	30 pF[1]	
1	0.17 A			250 V
2	0.33 A			500 V
3	0.67 A	0.5 A	0.42 A	1000 V
4	1.33 A			2000 V
5	2.67 A			4000 V
6	5.33 A			8000 V

[1]The peak current into the 500 ohm resistor will vary, depending on the capacitive loading of the socket and peripheral wiring. The value shown in the 0 pF column represents the calculated value assuming zero capacitance. Values up to 30 pF are permissible, and the value of Ipr obtained with this maximum value of capacitance is shown under the column 30 pF. The MINIMUM permitted Ipr is 63% of the actual Ips level obtained for the same stress step.

4.2.2.2 Classification Testing

As a minimum, a sample of devices shall be characterized for the device ESD threshold using the voltage steps shown in Table 1. Sample size is discussed in EOS/ESD-S5.

Each pin combination of the DUT as described in Table 2 is tested by applying three pulses at one-second intervals in both polarities.

Table 2: Pin Combinations for Device Classification Testing

	Terminal A: Each pin individually connected to terminal A with the other(s) floating	Terminal B: The common combinations of all like-name pins connected to terminal B
1[1]	All pins except Vps1[2]	All Vps1 pins
2[1]	All input and output pins	All other input-output pins (tied together)

[1]No-connects are not to be tested.

[2]Repeat pin combination 1 for each named power supply and for ground (that is, where Vps1 is Vdd, Vcc, Vbb, GND, +Vs, -Vs, and so on).

Between surge levels, device functionality must be verified. If one or more devices fail, repeat the test at the next lower surge level using new devices. This will determine whether the devices are sensitive to stress level hardening. The device is classified at the voltage level at which the sample size passes. This is the ESD Withstand Voltage. See Table 3 for the device classification by sensitivity levels.

NOTE

The voltage classification levels are relative. A 2000 V sensitivity does not imply that the part can withstand any environment with electrostatic voltages up to 2000 V, but only that it can withstand a controlled environment with this voltage in the HBM waveform category. Other waveforms, such as charged device models, do occur and can be more damaging. This classification allows for comparison of devices using a repeatable method.

Table 3: Device Classification by Sensitivity Levels

Class	Sensitivity Level
1A	0 to 249 V
1B	250 to 499 V
1C	500 to 999 V
1D	1000 to 1999 V
2	2000 to 3999 V
3A	4000 to 7999 V
3B	above 8000 V

It is important when testing to work from the original standard. Parts of the standards are copied here for reference, but to ensure repeatability, testing must be done to the original specifications. Testing according to EOS/ESD-S5 *must be done* because it calls for two part verification: short circuit and 500 ohm circuit.

4.3 LABELING REQUIREMENTS

The ESD Sensitivity Voltage Level shall be included in the device's specifications and, where possible, on the device's label.

APPENDIX A

REFERENCED DOCUMENTS

A.1 EL-CLASS DIGITAL DOCUMENTS

EL-Class Number	Document Title
EL-00052-04	*DEC STD 052-4 Local Direct Connection (No Modem) for Serial Asynchronous Terminals and System Interfaces*
EL-00067-01	*DEC STD 067-1 Electrostatic Discharge-Sensitive Devices: In Engineering Facilities*
EL-00067-02	*DEC STD 067-2 Electrostatic Discharge-Sensitive Devices: Procedures and Protective Packaging Material (proposed)*
EL-00067-03	*DEC STD 067-3 Electrostatic Discharge-Sensitive Devices: In Manufacturing Facilities (proposed)*
EL-00067-04	*DEC STD 067-4 Electrostatic Discharge-Sensitive Devices: In Customer Service Areas (proposed)*
EL-00067-05	*DEC STD 067-5 Electrostatic Discharge-Sensitive Devices: Related Materials and Products (proposed)*
EL-00103-00	*DEC STD 103-0 Electromagnetic Compatibility (EMC) Hardware Design Requirements*
EL-00119-00	*DEC STD 119-0 Digital Product Safety - Introduction and General Requirements*
EL-00178-00	*DEC STD 178-0 Digital Identification Marking Requirements - Introduction*
EL-MF067-00	*Incoming Inspection Procedure of ESD Protective Packaging Material*
EL-MF277-00	*Electrical Safety Product Test Procedure*

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A.2 OTHER DOCUMENTS

Document Number	Document Title
MIL-STD-883C	*Method 3015.6 ESD Sensitivity Classification, 12 February 1988. (HBM of 1500 ohms, 100 pF, for IC testing)* Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
EIA-541	*Packaging Material Standard for ESD Sensitive Items* Electronic Industries Association Engineering Department 2001 Eye Street, N. W. Washington, D. C. 20006

Document Number	Document Title
EOS/ESD-S5	*Human Body Model (HBM) Electrostatic Discharge Sensitivity Testing, 1988* EOS/ESD Association, Inc. Norstar Building 200 Liberty Plaza Rome, NY 13440

APPENDIX B

RELATED DOCUMENTS

B.1 EXTERNAL DOCUMENTS

Document Number	Document Title
ANSI/NFPA 70	*National Electric Code 1987 Handbook, Section 12-4.1.3. 8, NFPA, Fourth Edition* American National Standard Institute/National Fire Protection Association Batterymarch Park Quincy, MA 02269
ANSI/NFPA 99	*Health Care Facilities, Section 3-3.6.2: Conductive Flooring, 1987.*
ASTM D 257-78	*D-C Resistance of Insulating Materials* American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
C.S.A. STD C22.2 No. 0.4-M1982	*Bonding and Grounding of Electrical Equipment (Protective Grounding), Section 2.1, December, 1982* Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario Canada M9W 1R3
DOD-HDBK-263	*ESD Control Handbook for Protection of Electrical and Electronic Parts* Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
DOD-STD-2000-1B	*Military Standard Soldering Technology*
ECMA TR/40	*Electrostatic Discharge Immunity Testing of Information Technology Equipment, 1987* European Computer Manufacturers Association 114 Rue du Rhône Geneva, Switzerland

Document Number	Document Title
EOS/ESD	*EOS/ESD Association Glossary of Terms, 1987* EOS/ESD Association, Inc. Norstar Building 200 Liberty Plaza Rome, NY 13440
EOS/ESD-S1	*Standard for Protection of ESD Susceptible Items: Personnel Grounding Wrist-Straps, 1987*
EOS/ESD-S2	*Standard for Protection of ESD Susceptible Items: Personnel Garments, 1987*
EOS/ESD-DS4	*Standard for Protection of ESD Susceptible Items: Work Surfaces, 1988*
	Electrostatic Discharge (ESD) Protection Test Handbook, 2nd Edition, 1986 KeyTek Instrument Corporation 260 Fordham Road Wilmington, MA 01887
IEC 801-2	*Electromagnetic Compatibility for Industrial- Process Measurement and Control Equipment, Part 2: Electrostatic Discharge Requirements, Draft 4 (No date). (HBM: 330 ohms, 150 pF.)* International Electrotechnical Commission 3, Rue de Varembé Geneva, Switzerland
	Randy Hull, "Stress Hardening of Damage Thresholds Due to Cumulative ESD Pulse Testing" EOS/ESD Symposium Proceedings, 1988. Contact EOS/ESD Association (above) for copies.
UL 478	*Standard for Information-Processing and Business Equipment, Section 23, Fifth Edition, 1984* Underwriter's Laboratory Publications Stock 333 Pfingsten Road Northbrook, IL 60062
UL 84U4	*ESD Grounding System, 1988*

APPENDIX C

GLOSSARY

antistatic - Refers to a material that does not cause triboelectric charge generation. Although some documentation gives this material a resistivity range, this standard defines the term without adherence to a resistivity range. This is in accordance with internal purchase specifications, and with external standards such as EIA-541, all ASTM documentation, and EOS/ESD Association standards.

antistatic agent - A chemical compound that, when impregnated or formulated into or topically applied to a primary material or substrate, gives the primary material antistatic properties.

antistatic property - Refers to the prevention of triboelectric charge generation by effectively minimizing the production of an electrostatic charge when materials are separated from another surface.

audit - To examine for compliance to specifications of Digital standards.

barrier materials - Materials used to shield ESD sensitive materials from damage caused by ESD.

BJT - Bipolar Junction Transistor.

blooming - Continuous migration of the agent of the antistatic agent to the surface of the material.

buried metal layer - A Faraday shielding metallic layer laminated between two dissipative surfaces.

carbon suffused nylon - Nylon treated with a carbon compound to form conductive fibers.

CDM - Charged device model, a model characterizing a particular ESD failure mechanism in which a device isolated from ground is charged and is subsequently discharged, causing a high current amplitude, short-duration-discharge pulse. The CDM typically has a low discharge resistance (less than 10 ohms) and inductance (less than 100 nH).

certification - Requires demonstration of knowledge of requirements of training program as described in DEC STD 067. Certification is to be renewed annually.

charge - (Q), See coulomb.

CMOS - complimentary metal oxide semiconductor.

conductor - A material made of metal or impregnated with metal or carbon particles or other conductive materials, or whose surface has been treated with such materials through a process of lacquering, plating, metalizing, or printing. A conductive material for static control purposes shall have a surface resistivity less than 1e+5 ohms/square or 1e+3 ohm-cm if volume conductive. A conductive material is not necessarily antistatic.

conservation of charge - The charge on the one material will always be matched with an opposite but equal charge on the other material.

corona - Ionization of the surrounding atmosphere caused by electric potential on a conductor.

corrosivity - Characteristic property of a material that demonstrates its propensity to cause other materials to corrode.

coulomb - The usual unit to measure a quantity of electricity; the quantity transferred by a current of one ampere in one second.

current - A movement or flow of charge, the rate of such flow is measured in amperes.

degradation - Product performance is within the original parameters of the product specification, but performance has shifted from original measurements.

dielectric breakdown - A threshold effect in a dielectric medium where at some electric field strength across the medium, bound electrons become unbound and travel through the medium as a current. In solid media, the region of the current path can be permanently damaged. The units of measurement are usually volts per unit of thickness.

DUT - Device under test.

E-PROM - Erasable programmable read only memory.

ECL - Emitter coupled logic.

EDP equipment - Electronic data processing equipment.

EDP failures - These terms are identified in DEC STD 103 for use in classification of Digital's electronic data processing (EDP) equipment. (See DEC STD 103 for further discussion of this testing and classification). Typically, customer operations and other areas understand soft failures to be the first two categories listed below, and hard failures to be the last.

soft failure - A failure in EDP equipment that is self-correcting.
hard failure - A failure in EDP equipment requiring operator intervention to correct (no actual equipment damage).
hardware failure - Actual equipment damage to EDP equipment.

electrical overstress (EOS) - The electrical stressing of items beyond their electrical specifications. Includes ESD, voltage transients, lightning, and the like.

electrically continuous surface - A surface that is electrically conductive in that the current can be passed at an applied voltage between any two points on its physical surface.

electrostatic charge - Electrical charge at rest. The electrical charge is due to the transfer of electrons within a body (polarization) or from one body to another.

electrostatic discharge (ESD) - The transfer of electrical charge between bodies at different electrostatic potentials.

electrostatic discharge sensitivity - A property which quantifies the material's inherent susceptibility to either catastrophic failure or latent damage when exposed to sources of ESD.

electrostatic field - The region surrounding an electrically charged object in which another electrical charge will experience a force. Quantitatively, it is the voltage gradient between two points at different potentials.

engineering abbreviations:

G (giga) billion or 1e+9
M (mega) million or 1e+6
k (kilo) 1,000 or 1e+3
m (milli) thousandth or 1e-3
u (micro) millionth or 1e-6
n (nano) billionth or 1e-9)

engineering notation - A numbering system where exponentials are listed with "e±#". For example, 100 is equivalent to 1e+2, 0.0723 is equal to 7.32e-2.

ESD - Electrostatic discharge.

ESD protective - A property of materials capable of one or more of the following: preventing the generation of static electricity; dissipating electrostatic charges over its surface or volume; providing shielding from ESD or electrostatic fields.

ESD simulator - A device capable of generating an ESD waveform for the purpose of testing.

EUT - Equipment under test.

failures - When the equipment of device no longer works as specified. See also EDP failures.

Faraday shield or cage - Also called Faraday screen. A network of wires connected to a common conductor at one end to provide electrostatic shielding without affecting electromagnetic waves. The common conductor is usually grounded.

field attenuation - To reduce the intensity level or field of a static voltage.

GaAs FET - Gallium arsenide field effect transistor.

ground - Connected effectively with the general mass of the earth through a grounding system of sufficiently low impedance and having a current capable at all times, under the most severe conditions liable to arise in practice, of preventing any current in the grounding conductor from causing a harmful voltage to exist between exposed conductive parts of equipment and neighboring conductive surfaces that are likely to be in good contact with earth ground.

hard ground - Connection to earth ground without series resistance.

HBM - human body model - A circuit that simulates the ESD waveform of a person for testing purposes.

high voltage area - Area where the potential between the part and earth ground or any other accessible part is more than 42.4 volts and the continuous current through a 1500 ohm resistor connected across the potential exceeds 5 mA.

high voltage hazard - See high voltage area.

high-pot tester - (Also called Hi-Pot)A metered, variable high voltage supply, often capable of delivering 20 kV to 50 kV for the purpose of testing the dielectric strength of a material.

humidity dependent - ESD protective material that changes its resistivity and other properties as the ambient humidity level changes.

insulator, electric - A material with surface resistance of greater than 1e+12 and/or a volume resistance of 1e+10.

intimate packaging material - Those materials in direct contact with the packaged item.

ion current meter - An instrument used to check the performance of ion generators.

ion - An atom or molecule with either a positive or negative charge.

ionization - The process by which a neutral atom or molecule, such as air, acquires a positive or negative charge.

ionizers - A family of instruments designed to ionize the atmosphere generally surrounding a sensitive device or area, and used to reduce possible ESD damage due to static charges building in the area. Included in this family are the following types: hood ionizers, pulsed dc, steady state dc, high voltage ac and nuclear.

isolated conductor - A conductive material isolated from ground by an insulator.

JFET - Junction field effect transistor.

latent failure - A hidden failure that does not result in an immediately detectable defect condition, but that can result in failure during the operating life of the part.

magnetic field - A condition of space in the vicinity of a magnet or electric current which manifests itself as a force on magnetic objects within that space.

megohmeter - An instrument specially designed to read the higher values of resistance, (up to 1e+14 ohms) and capable of supplying 100 volts across the EUT.

melamine - Resin used in making decorative hard laminates.

MOSFET - Metal oxide semiconductor field effect transistor.

MTBF - Mean time between failures.

op-amp - operational amplifier - The op-amp is a dc-coupled multistage linear amplifier that, in an ideal device, has infinite input impedance and infinite gain. While the ideal op-amp remains an unobtainable goal, voltage gains of up to 100,000 or more can be obtained.

outgassing - Release of a gaseous material from the surface of a material due to environmental conditions.

personnel grounding devices - Includes static dissipating smocks, static dissipative shoes, wrist grounding straps, toe grounding straps, heel grounding straps, and ground connections convenient to the operator.

phenolic - A stable thermo-set plastic.

pink material - A plastic material traditionally manufactured for protecting ESD sensitive materials. Its properties are NOT guaranteed by the color; pink materials may be tribogenerating, insulative, or otherwise non-protective.

resistance - The characteristic of a material that dictates the amount of current that will pass through the material at a given voltage.

resistivity, surface - The ratio of dc voltage to the current that passes across the surface of the system. In this case, the surface consists of a square unit of area. In effect, the surface resistivity is the resistance between two opposite sides of a square and is independent of the size of the square or its dimensional units. Surface resistivity is expressed in ohms/square.

resistivity, volume - The ratio of the dc voltage per unit thickness applied across two electrodes in contact with a sample to the amount of current per unit area passing through the system. Volume resistivity is given in ohm-centimeters.

Schottky diode - A diode made by a metal process, such as aluminum and copper or nickel, often a fast switching diode with a forward voltage drop of 0.2 to 0.5 volt.

SCR - silicon control rectifier - A rectifier used to control voltage levels in circuits such as electric drills, incandescent lamps, and the like.

shield, electromagnetic - A screen or other housing placed around devices or circuits to reduce the effects of external electric or internal magnetic fields. See Faraday shield.

shield, electrostatic - A barrier or enclosure that prevents the penetration of an electrostatic field. An electrostatic shield may not offer much protection against electromagnetic fields. See Faraday shield.

silver coated nylon - Nylon treated with a silver compound to form conductive fibers.

sloughing - Giving off bits and particles of the product.

soft ground - Connection to hard ground through a protective resistor, typically one megohm. See DEC STD 067-3.

static dissipative - A property of a material having a surface resistivity of at least 1e+5 ohms/square or 1e+3 ohm-cm volume resistivity, but less than 1e+12 ohms/square surface resistivity or 1e+10 ohm-cm volume resistivity.

surfactant - An antistatic agent that is topically applied to the surface of a non-ESD protective material to cut its propensity to tribogenerate or be an insulator.

triboelectric generation - The generation of electrostatic charges when two pieces of material in intimate contact are separated. Substantial generation of static electricity can be caused by contact and separation of two materials or by rubbing two substances together. (See also triboelectric series).

triboelectric series - A list of substances arranged so that one substance can become positively charged when separated from one substance farther down the list, or negatively charged when separated from one farther up the list. The series main utility is to indicate likely resultant charge polarities after triboelectric generation. However, this series is derived from specially prepared and cleaned materials tested in very controlled conditions. In everyday conditions, materials may respond differently from the indications of the series, and thus, the series should be used only as a guide.

voltage - Electromotive force expressed in volts.

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